Empirical Analysis of Financial Stability of Agro-Clusters in Uzbekistan

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Abstract

This study examines the financial stability of agro-clusters with a focus on identifying key determinants that influence long-term asset growth and overall economic sustainability. Using cross-sectional data, the research applies an Ordinary Least Squares (OLS) regression model to analyze the impact of workers, depreciation coefficient, validity coefficient, and current assets on long-term assets. The empirical results reveal that labor capacity, liquidity, and operational efficiency have a positive and statistically significant effect on financial stability, while the depreciation coefficient shows a negative but insignificant relationship. Diagnostic tests confirm the reliability and robustness of the model, including normality of residuals and absence of heteroscedasticity. The findings highlight the importance of efficient resource management, access to financial capital, and effective asset utilization in strengthening agro-cluster performance. From a policy perspective, the study suggests that improving workforce productivity, enhancing financial accessibility, and promoting modern management practices are essential for achieving sustainable growth in the agricultural sector. The results contribute to the existing literature by providing empirical evidence on the financial dynamics of agro-clusters, particularly in the context of developing economies such as Uzbekistan.

Keywords: Agro-clusters; Financial stability; Long-term assets; OLS regression; Liquidity; Labor productivity; Asset management; Agricultural economics; Uzbekistan; Economic efficiency

1. Introduction

Financial stability of agro-clusters in Uzbekistan is a key factor for ensuring sustainable agricultural development and national economic growth. Agro-clusters integrate production, processing, and distribution within a single value chain, which increases efficiency and competitiveness. In Uzbekistan, especially in cotton-textile and fruit-vegetable clusters, financial stability is closely linked to profitability, cost reduction, and productivity growth. Profit is considered a central indicator of financial sustainability, as it reflects the overall effectiveness of enterprise activity, including output quality, labor productivity, and market performance.

One of the main challenges in maintaining financial stability is the dependence on external factors such as price volatility, climate risks, and seasonal cash flows. Agricultural clusters often face liquidity problems due to delayed revenues and high upfront production costs. Therefore, modern financial mechanisms such as insurance, risk hedging, and diversification of funding sources are essential. Studies show that improving financial resource management and introducing digital financial tools (agro-fintech) can significantly strengthen the resilience of agro-clusters

Recent reforms in Uzbekistan have played an important role in enhancing the financial sustainability of agro-clusters. The transition from a state-controlled system to a market-oriented model, particularly in cotton production, has introduced new financial instruments such as futures contracts, subsidies, and access to credit using land rights as

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collateral. These reforms aim to improve liquidity, increase investment attractiveness, and strengthen the overall financial structure of clusters.

Effective management systems and integration within the cluster structure are critical for financial stability. Proper coordination between farmers, processors, and exporters reduces transaction costs and improves resource allocation. Research indicates that adopting modern management practices and digital technologies enhances financial control, transparency, and decision-making within agro-clusters, leading to better financial outcomes. Financial stability of agro-clusters in Uzbekistan depends on a combination of internal efficiency, external support mechanisms, and ongoing institutional reforms. Strengthening financial management, expanding access to financing, and adopting innovative technologies are essential for improving resilience. As Uzbekistan continues its agricultural transformation, agro-clusters will play a crucial role in ensuring economic stability, export growth, and rural development.

2. Literature review

Financial stability in agro-clusters has become a central topic in agricultural economics, particularly in developing and transition economies. Agro-clusters integrate production, processing, and distribution activities, enabling cost efficiency and improved financial performance (Porter, 1998). Empirical studies suggest that clusters enhance economies of scale and reduce transaction costs, which positively influence financial sustainability in agriculture (Swinnen & Maertens, 2007). This integrated structure allows agro-clusters to better withstand market volatility and maintain stable income flows.

Access to finance is one of the most critical determinants of financial stability in agro-clusters. Research shows that limited access to credit and underdeveloped financial markets constrain investment in technology and infrastructure, reducing long-term productivity (World Bank, 2020). Conversely, the availability of financial instruments such as agricultural loans, subsidies, and microfinance significantly improves liquidity and supports sustainable growth (FAO, 2017). Studies also highlight the importance of contract farming arrangements, which provide financial security and reduce uncertainty for farmers (Bellemare, 2012).

Risk management is another key factor influencing agro-cluster financial stability. Agricultural production is highly exposed to risks such as climate change, price fluctuations, and supply chain disruptions. Empirical evidence indicates that diversification, crop insurance, and forward contracts can mitigate financial risks and enhance resilience (Birthal et al., 2015). In addition, digital technologies and data analytics are increasingly being used to improve forecasting, risk assessment, and financial planning in agro-clusters (OECD, 2021). Institutional support and governance structures play a vital role in ensuring financial stability within agro-clusters. Strong regulatory frameworks, transparent policies, and government support programs contribute to improved access to markets and financial resources (UNIDO, 2019). In transition economies, including Uzbekistan, reforms aimed at promoting cluster development have enhanced financial sustainability by facilitating investment and improving coordination among stakeholders.

Human capital and managerial efficiency are also essential components of financial stability. Studies show that skilled labor, effective management practices, and knowledge transfer significantly improve productivity and financial outcomes in agro-clusters (Trienekens, 2011). Training and capacity-building programs enable farmers and managers to adopt modern technologies and financial strategies, thereby increasing efficiency and profitability.Furthermore, value chain integration is a critical driver of financial stability in agro-clusters. Vertical coordination among producers, processors, and distributors reduces transaction costs and enhances market access (Reardon et al., 2009). This integration improves cash flow management and ensures more predictable revenue streams, which are essential for financial sustainability.

The role of innovation and technology adoption in agro-clusters cannot be overlooked. Research indicates that the use of modern agricultural technologies, such as precision farming and digital platforms, improves productivity and reduces operational costs (Klerkx et al., 2019). These innovations contribute to financial stability by enhancing efficiency and enabling better resource allocation. Market access and export orientation also significantly influence agro-cluster financial performance. Studies show that clusters engaged in export activities tend to achieve higher profitability and financial stability due to access to larger and more competitive markets (Barrett et al., 2012). Export-oriented clusters benefit from economies of scale and improved price stability.

3. Methods

This study employs a quantitative research approach to examine the determinants of financial stability in agro-clusters, using long-term assets as the dependent variable. The analysis is conducted based on cross-sectional data and applies

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the Ordinary Least Squares (OLS) regression model to estimate the relationships between long-term assets and key explanatory variables, including workers, depreciation coefficient, validity coefficient, and current assets. Prior to regression, Karl Pearson pairwise correlation analysis is used to assess the strength and direction of relationships among variables. To ensure model reliability and validity, several diagnostic tests are performed, including histogram analysis for normality of residuals and the Breusch–Pagan / Cook–Weisberg test for heteroscedasticity. Additionally, a reliability test using Cronbach's alpha is conducted to confirm the internal consistency of the selected indicators. All statistical analyses are carried out using Stata software.

4. Results

The sixplot diagnostic figure provides a comprehensive overview of the distribution and behavior of long-term assets in the dataset.

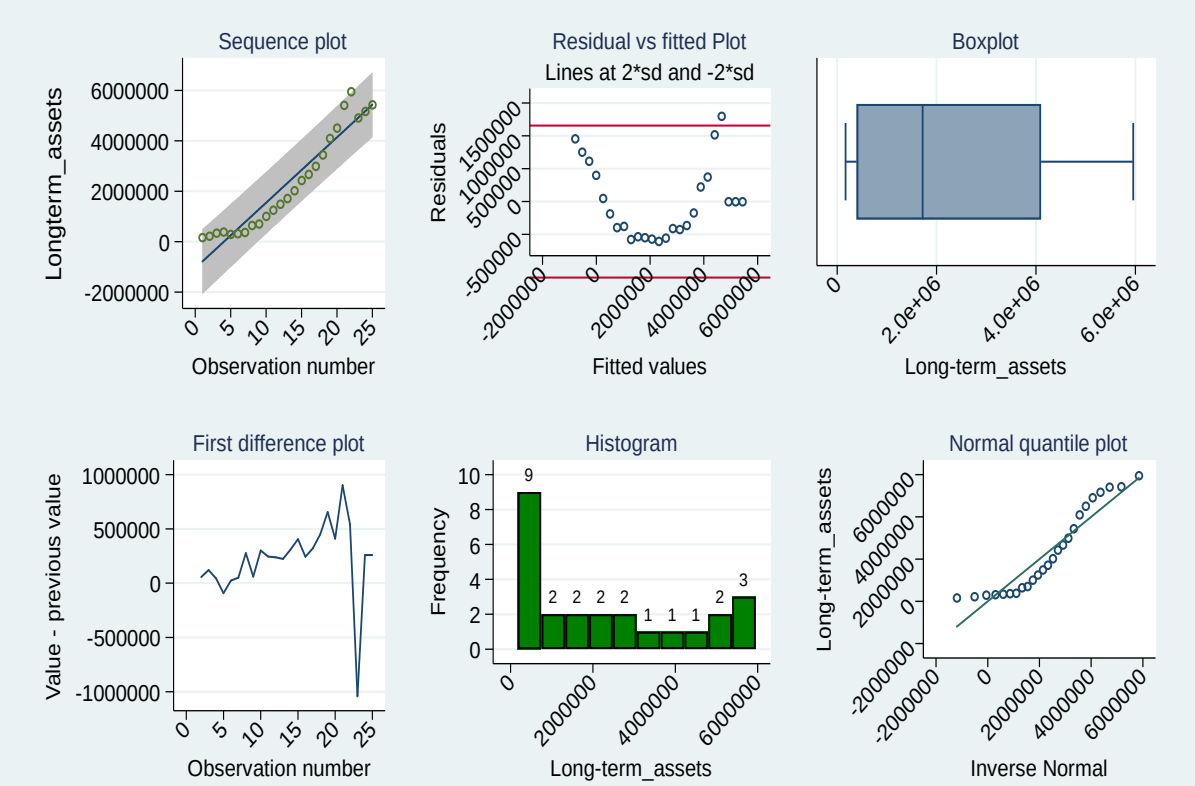

Figure 1. Sixplot diagnostic analysis of long-term assets

The sequence plot indicates an overall increasing trend, suggesting growth in asset values over observations, while the first-difference plot highlights fluctuations and potential volatility between consecutive periods. The residual versus fitted plot shows no strong systematic pattern, implying that the model fit is reasonably appropriate, although some dispersion exists. The histogram and boxplot reveal a right-skewed distribution with possible outliers, indicating that a few observations have significantly higher asset values. Additionally, the normal quantile plot suggests partial deviation from normality, especially in the tails.

The scatter plots illustrate the relationship between long-term assets and several explanatory variables, including workers, depreciation coefficient, validity coefficient, and current assets. A strong positive relationship is observed between long-term assets and both the number of workers and current assets, indicating that firms with larger labor forces and higher current asset levels tend to invest more in long-term assets. Similarly, the validity coefficient also shows a positive association, suggesting that better operational efficiency or asset utilization contributes to the growth of long-term investments. In contrast, the depreciation coefficient exhibits a negative relationship with long-term

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assets, implying that higher depreciation rates are associated with lower levels of long-term asset accumulation. This may reflect aging assets or inefficient capital management within firms (Figure 2).

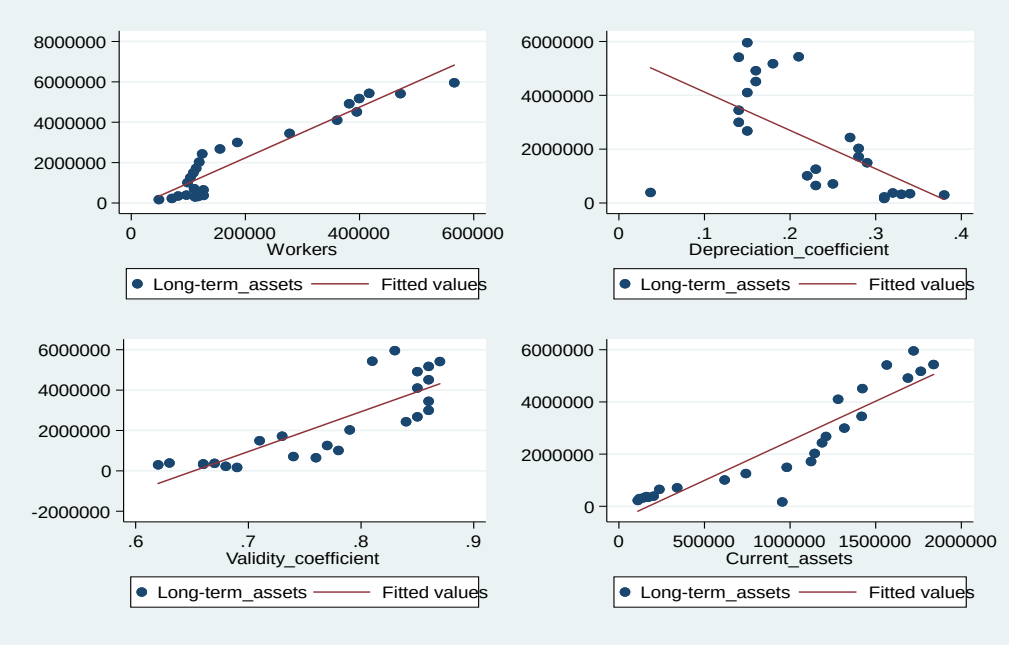

Figure 2. Relationship between long-term assets and key financial indicators

The Karl Pearson pairwise correlation matrix reveals strong and statistically significant relationships among the variables. Long-term assets are highly positively correlated with workers (0.949), validity coefficient (0.833), and current assets (0.918), indicating that increases in labor force, operational efficiency, and short-term resources are closely associated with higher long-term asset accumulation. In contrast, the depreciation coefficient shows a significant negative relationship with long-term assets (-0.602), suggesting that higher depreciation is linked to lower asset value or aging capital. Additionally, workers and current assets are also strongly positively correlated, while depreciation maintains negative correlations with most variables. Overall, the results indicate a consistent pattern where productive capacity and resource availability enhance asset growth, whereas depreciation negatively affects financial stability.

Table 1: Karl Pearson pairwise correlations matrix test

Variables	(1)	(2)	(3)	(4)	(5)
(1) Long term assets	1.000				
(2) Workers	0.949*	1.000			
	(0.000)				
(3) Depreciation coefficient	-0.602*	-0.560*	1.000		
	(0.001)	(0.004)			
(4) Validity coefficient	0.833*	0.686*	-0.613*	1.000	
	(0.000)	(0.000)	(0.001)		
(5) Current assets	0.918*	0.776*	-0.533*	0.850*	1.000
	(0.000)	(0.000)	(0.006)	(0.000)	

**** p<0.01, ** p<0.05, * p<0.1*

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The first-stage OLS regression results demonstrate a very strong overall model fit, with an R-squared value of 0.988, indicating that approximately 98.8% of the variation in long-term assets is explained by the included independent variables. The model is statistically significant (Prob > F = 0.000), confirming that the explanatory variables jointly have a meaningful impact on long-term assets. This suggests that the selected financial and operational indicators are highly relevant in explaining asset formation within agro-clusters.

Table 2: First stage OLS regression model

Long term assets	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Workers	7.694	.525	14.66	0	6.599	8.789	***
Depreciation coefficient	-218414	748602.91	-0.29	.773	-1779972	1343143	
Validity coefficient	3015156	1159871.4	2.60	.017	595707	5434606	**
Current assets	1.169	.176	6.66	0	.803	1.536	***
Constant	-2635248	871980.39	-3.02	.007	-4454167	-816329	***

Mean dependent var	2322586.440	SD dependent var	1990663.772
R-squared	0.988	Number of obs	25
F-test	426.919	Prob > F	0.000
Akaike crit. (AIC)	693.655	Bayesian crit. (BIC)	699.750

*** *p<.01, ** p<.05, * p<.1*

Among the independent variables, workers show a strong positive and highly significant effect (coef. = 7.694, $p < 0.01$), indicating that an increase in labor force is associated with a substantial rise in long-term assets. This reflects that labor expansion supports production capacity and encourages investment in fixed assets. Similarly, current assets have a positive and statistically significant coefficient (1.169, $p < 0.01$), implying that firms with higher liquidity and short-term resources are more capable of investing in long-term assets.

The validity coefficient also exhibits a positive and significant relationship (coef. = 3,015,156, $p < 0.05$), suggesting that improved operational efficiency or asset utilization contributes to the growth of long-term assets. In contrast, the depreciation coefficient has a negative but statistically insignificant effect ($p = 0.773$), indicating that although depreciation may theoretically reduce asset value, it does not have a meaningful impact in this model. This could be due to variability in depreciation practices or limited sample size.

Finally, the constant term is negative and statistically significant, which may indicate baseline structural factors affecting long-term assets when all explanatory variables are held constant. Overall, the findings highlight that labor input, liquidity, and operational efficiency are key drivers of long-term asset accumulation, while depreciation plays a less influential role. The results provide strong empirical evidence for understanding financial stability and investment behavior in agro-clusters.

The histogram of residuals, combined with the overlaid normal density curve, is used to assess whether the regression errors follow a normal distribution. The distribution appears to be approximately bell-shaped, with most residuals clustered around zero, indicating that the model's predictions are generally unbiased. However, there is a slight skewness and a few extreme values on the left tail, suggesting minor deviations from perfect normality. Overall, the residuals reasonably satisfy the normality assumption, which supports the validity of statistical inference in the regression model, although the presence of outliers should be considered in further analysis.

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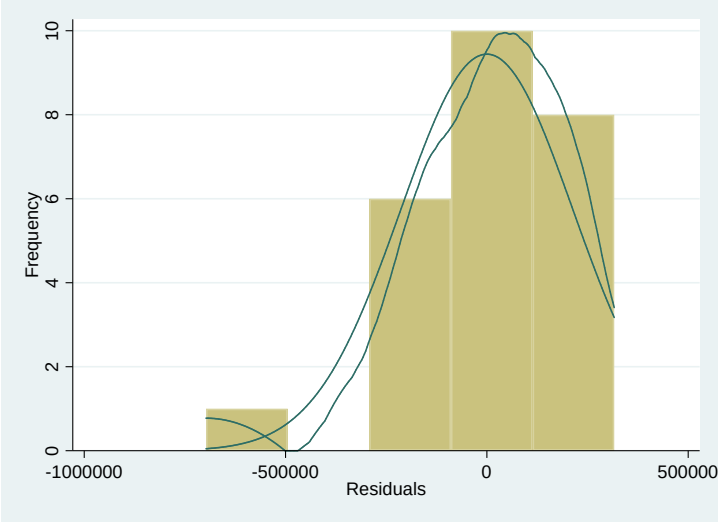

Figure 3. Normal density histogram of regression residuals

The Breusch–Pagan / Cook–Weisberg test results indicate that the null hypothesis of constant variance (homoskedasticity) cannot be rejected, as the p-value (0.4920) is significantly higher than conventional significance levels (0.01, 0.05, or 0.10). This means that there is no statistical evidence of heteroscedasticity in the model, and the variance of the residuals can be considered constant across fitted values of long-term assets. Consequently, the OLS regression assumptions are satisfied in terms of homoscedasticity, and the estimated coefficients, standard errors, and statistical inferences are reliable.

The reliability analysis results indicate a high level of internal consistency among the standardized items used in the scale. With an average inter-item correlation of 0.7321, the variables show strong positive relationships with each other, suggesting that they measure a common underlying construct related to financial stability. The inclusion of the reversed item (depreciation coefficient) ensures consistency in the direction of measurement across variables. Furthermore, the scale reliability coefficient (Cronbach's alpha) of 0.9318 is very high, exceeding the commonly accepted threshold of 0.7, which confirms excellent reliability. Overall, the results demonstrate that the selected five items form a robust and consistent scale suitable for further econometric and statistical analysis.

5. Discussion

The empirical results highlight that financial stability in agro-clusters is strongly driven by internal operational and financial capacities. The OLS regression findings reveal that workers, current assets, and the validity coefficient have significant positive effects on long-term assets, indicating that labor resources, liquidity, and operational efficiency are critical determinants of capital accumulation. These results are consistent with the correlation analysis, which also shows strong positive relationships among these variables. This suggests that agro-clusters with better resource management and stronger workforce capacity are more likely to achieve sustainable financial growth.

At the same time, the depreciation coefficient demonstrates a negative but statistically insignificant effect, implying that asset wear and aging do not play a decisive role in determining long-term asset levels within the sample. This may be due to differences in accounting practices or the relatively small sample size. Additionally, diagnostic tests confirm the robustness of the model: the residuals are approximately normally distributed, and the Breusch–Pagan test indicates no heteroscedasticity, ensuring that the regression estimates are reliable. The high reliability coefficient (Cronbach's alpha = 0.9318) further supports the internal consistency of the variables used in the analysis.

From a practical perspective, these findings emphasize the importance of strengthening financial management, improving liquidity, and investing in human capital within agro-clusters in Uzbekistan. Policies aimed at enhancing workforce productivity, ensuring access to financial resources, and improving operational efficiency can significantly contribute to long-term asset growth and overall financial stability. Moreover, reducing inefficiencies related to asset utilization and promoting modern financial practices can further enhance resilience, making agro-clusters more competitive in both domestic and international markets.

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6. Conclusion

The findings of this study confirm that the financial stability of agro-clusters is largely influenced by key internal factors such as labor capacity, liquidity, and operational efficiency. The regression results demonstrate that workers, current assets, and the validity coefficient significantly contribute to the growth of long-term assets, highlighting their critical role in strengthening the financial foundation of agro-clusters. In contrast, the depreciation coefficient does not show a statistically significant effect, suggesting that asset aging is less influential compared to productive and financial capabilities. The model exhibits strong explanatory power, and diagnostic tests confirm the reliability and validity of the results.

From a policy and managerial perspective, the study emphasizes the need to focus on improving workforce productivity, ensuring sufficient access to financial resources, and enhancing asset utilization efficiency. Strengthening these areas will not only support sustainable investment in long-term assets but also improve the overall resilience and competitiveness of agro-clusters in Uzbekistan. Therefore, integrating effective financial management practices with institutional support and innovation will be essential for achieving long-term economic stability and growth in the agricultural sector.

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